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# Interaction Design of Augmented Education Environments

Hybrid Reality to Enhance Learning Experience, Knowledge  
Transfer and Performance & Training Support of  
Technicians/Engineers in the Aviation / Automotive Industry

J.Christian, R.Behringer, H.Krieger,  
A.Holzinger, D. Moore



# Authors

- Working at Leeds Metropolitan University, Medical University Graz, ipCenter.at, and BRP Rotax.
- Diverse background, addressing both academic and industrial issues of new learning technologies.
- Main work done at BRP Rotax.

# Context of this Project

- Augmented / Mixed Reality (AR/MR) have recently gained much attention in mobile phone market.
- In this project:
  - AR/MR employed in a **hybrid reality** (real world + virtuality/reality continuum) working/training environment.
  - Users: instructors / trainees in technical domains (aircraft maintenance, automotive service).

# Status of Project

- Planning and design complete.
- Low-fidelity prototypes ready.
- Hi-fidelity prototypes in progress.
- User study in planning.

# Augmented / Mixed Reality

- The *Reality-Virtuality-Continuum* describes the *Linking* the real and virtual world.
- Enriching the real world with digital information, registered into the user's perception of the environment.
- Direct linking of information with real world provides intuitive understanding of information relevance and context.

Reality

Mixed Reality

Virtuality

Augmented Reality

Augmented Virtuality



# Principles of Visual AR

- Augmentation of the physical world with interactive, context-aware information (e.g. 2D and 3D content), registered with real environment.
- Using ubiquitous and pervasive computing environments for linking digital information with real world.

# General Challenges for AR/MR

- Development of AR/MR system:
  - Authoring of content.
  - Platform and system capabilities.
- Operation of AR/MR systems:
  - Inherent complexity, e.g. calibration.
  - User acceptance.
- From laboratory settings into the everyday workplace and environment .



# Project Description

- Apply AR and MR in **advanced training** of BRP Inc. customers / technicians / engineers at BRP's Technical Training Institute.
- Manuals , vehicle/engine systems and vehicles/engines are augmented with digital information, to train individuals and teams worldwide on various innovative complex technologies.
- First experience can be gained from design and feedback on first demonstrators and prototypes in the real training environment with real tasks to be performed.

# Specific Aims & Objectives

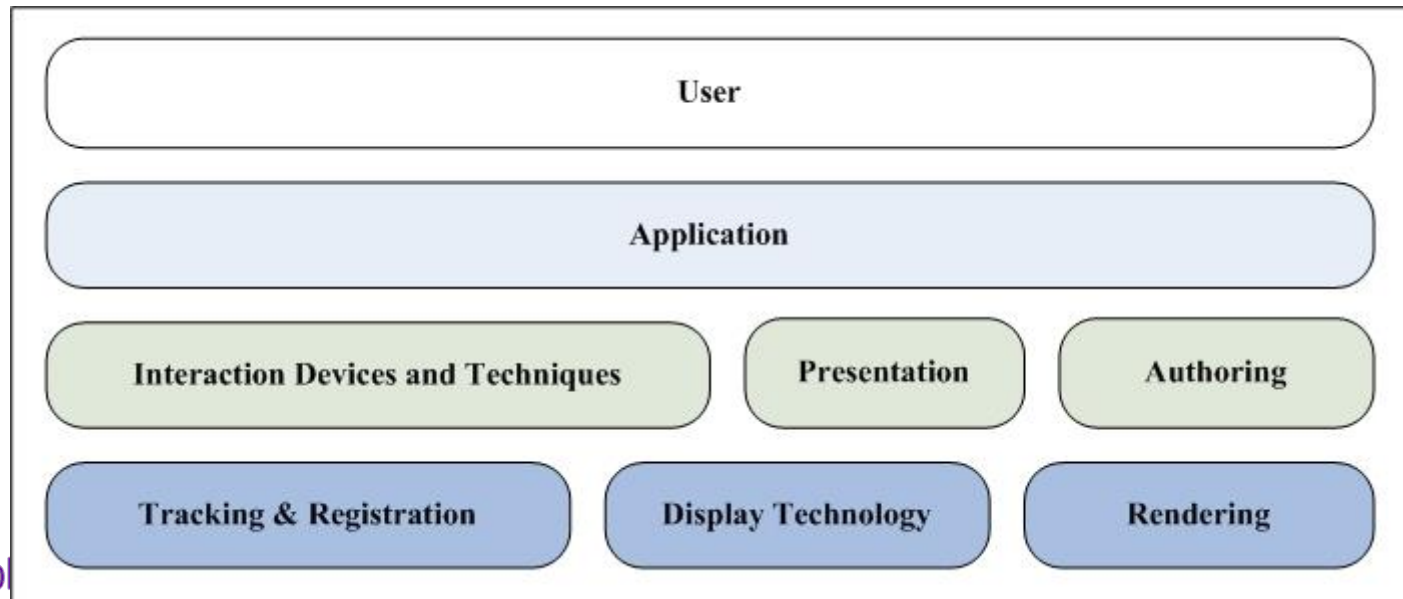
- Enhance the technical communication (documentation/ training) experience (like e.g. manuals, guides,...) in general.
- Enhance instructors' and trainees' understanding of complex technical operating procedures/systems by using optional AR content.
- Enhance the learning of maintenance, repair and overhaul (MRO) tasks.
- Upgrade not only employees' qualifications but enhancing their competencies.
- Assist to grow the social maturity of these emerging technologies/spaces in the relevant domain by further best-practices examples.

# Anticipated Outcome

- Aviation and automotive industry:
  - maintenance and service personnel to get access to assistive technologies in a very intuitive way.
  - to enhance their operation, work, training, and knowledge.
  - offering augmentation of the different senses like vision and audition, providing a media-rich interface.
- The impact of these emerging technologies on special target groups has not yet been investigated and validated by many research groups.

# Key Issues / Building Blocks

- Layer 4: user (ensuring good usability & user experience(UX))
- Layer 3: application (scenarios, domain, pattern,...)
- Layer 2: interaction (devices, framework, authoring,...)
- Layer 1: technology (tracking, display technology, ...)



# Research Design

(Agile) Research Design:

- User-centered Design
  - Technology Acceptance Model (TAM) as a basis for questionnaire/ interviews (non-directed) (visionary video(s) as reference examples).
- Activity/task-centered Design
  - Task analysis through field visits in real training and work settings.
- Systems Design
  - (Rapid-,Low-,High-Fidelity) prototyping as a basis for Usability Testing.

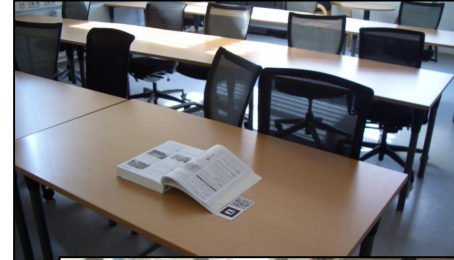
**„GOAL: Design user experiences (UX) that echo human behaviour and expectations.“**

# Design Process

- Phase 1: theoretical and empirical research to define a basic design process.
- **Phase 2:** use low fidelity prototypes and scribble/moodboard/storyboarding techniques to design first prototype.
- Phase 3: design short examples of high fidelity prototypes.
- Phase 4: perform qualitative and quantitative analysis at usability testing.

# Task-based Audience Segmentation

- Training Participant (study technical documentation and training material in the classroom).
- Hands-On Training (technology enhanced information on mechatronic systems by adding hybrid information (augmented information on task board))
- Technician working on the vehicle/engine.



# Requirements / User-Expectations Analysis

- Online Questionnaire.
- Semi-structured Interviews.

## Storyboards

- Using e.g. Celtx and Task/Job Cards to define the setting for Hybrid Reality



# Scenarios / Use Cases

- The following case studies have been defined:
  - AR Illustrated Parts Catalog (IPC).
  - AR Turbocharger Control Unit (TCU) System board.
  - AR CanAm Spyder Roadster oil level check.

# Prototypes

- Use of Low-Cost Rapid Prototyping.
- Use of Low-fidelity paper prototypes for user expectation feedback.
- Use of Available Authoring and Viewing Tools for High-fidelity Prototypes (e.g. BuildAR, PopCode,....)

# Scenarios

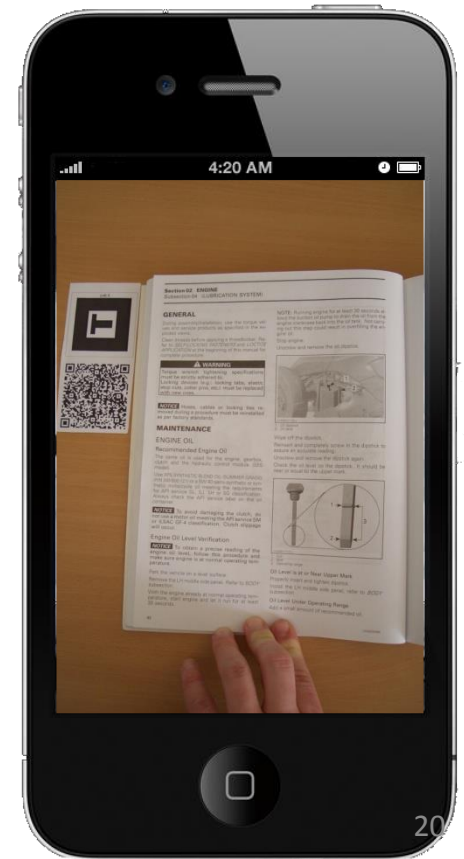
- Certification Training.
- Training guides on Smartphone.
- HR-enhanced task station.
- AR-enhanced vehicle/engine service and maintenance.

# Certification Training

- ePub of relevant Shop Manual sections on a tablet as training companion/support.
- Task sheets on the tablet as a guide/coach through the task path.
- Course feedback on the tablet.
- Course notes.
- Progression monitoring by Training Coach (Instructor).

# Training Guides on Smartphone

- 2D barcode marker provides automatically recognised target, allows showing related information.



# Enhanced Task Station

- HR view on large TFT display, co-located in work area.



# AR-enhanced Service/Maintenance

- Performing hands-on tasks directly on vehicle / engine.
- HR-view on iPad or head-worn media viewer.



# Preliminary Results / Lesson learned

- Lack of information concerning existence of such technologies and environments.
- Big interest and potential for such educational and workplace innovations.
- Novelty and necessary changes in the current authoring and publication processes.
- Lack of standardised “AR Browsers/Viewers”.



# Future Work

- Concrete visions or user requirements for future augmented education environments remain open and are subject of our further research steps.
- A Set of AR Guidelines / Style Guide for Content Creation.
- A common AR Browser standard (KHARMA or ARML) more than welcome.
- Quick and easy content creation/editing like Web 2.0 (Wikipedia, Facebook,...)->editor interface/platform.